On-Site Activity #1	*Educator Information*	Water Bugs

Major Concepts:
- Indicator Species
- Adaptation
- Ecosystem
- Aquatic macro invertebrates
- Water quality

Objectives:
- Describe three characteristics of aquatic macro invertebrates that helps them to survive in aquatic habitats
- Use key and field guides to identify aquatic macro invertebrates
- Name three indicator species and describe how they are used to determine water quality
- List and describe five factors necessary for a healthy wetland

Learning Skills:
- Observing
- Classifying
- inferring and predicting
- Reading informational material
- using keys
- identification guides

Location: Sandy Creek Park Wetlands

Group Size: 4-5 students

Time Considerations
Preparation in class - 15 minutes
Activity – 1.5 hours

Appropriate Season: Springtime or early fall

Materials provided by Park educator or teachers: nets, buckets, magnifying glasses, aquatic macro invertebrate's identification charts
Materials provided by the students: Pencil, comfortable clothing appropriate for a short hike.

Educator Information: You can split your group up into two sections: one collecting macroinvertebrates at the wetland and the other collecting at the creek. The students should have done the Pre-visit Activity #1, "Water Wonders" and Pre-Visit Activity #2, "Wetland Metaphors" previous to this activity.

Special Considerations: This activity requires a short hike on a paved greenway and through tall grasses. Students with physical disabilities should have not problem getting to the site, but may have difficulty with the activity as it occurs on the ground of the wetland. It is recommended that students wear closed shoes and put insect repellent on their feel and ankles to guard against ticks and chiggers. Be prepared for hot, humid weather and dress accordingly.

Credit: Eno River State Park Environmental Education Learning Opportunity

On-Site Activity #1	*Doing the Activity*	Water Bugs

1. Park staff or school teacher will lead a brief discussion focusing on: macroinvertebrates (macros), what they are and why they are important; **metamorphosis**, what is it and how it is accomplished; and indicator species, what they are and how they are used to determine the heath of the wetland and creek.

2. Park staff or school teacher will also cover the proper use of the sampling equipment and safety precautions that must be followed.

3. Separate the students into groups of four or five and have them collect aquatic samples following all safety procedures. Two to three groups should sample in the wetland and the other half should sample in creek.

4. After collecting samples in each of the locations, each group should identify the aquatic macroinvertibrates using the "Key to Common Macroinvertebrates." They should also use field guides to aid in identification.

5. Have them record their answers on the "Aquatic Sampling Data Sheet" and use their results to determine the **Stream Index Value** places macros into one of the three groups based upon how tolerant or sensitive they are to changes in water quality.

    a. Group I- macros that are very tolerant to water pollution. The dominant presence of Group I species is an indication of good water quality. Group I is given an index value of 3
    b. Group II – macros that are moderately tolerant to a reduction in water quality. They are given an index value of 2.
    c. Group III –macros that are tolerant to pollution. Their dominance indicated poor water quality. They are an index value of 1.

The students will learn how to calculate the Stream Index Value by using the formula:

(3 X # species in Group I)
(2 X # species in Group II)
\+ (1 X # species in Group III)
____
= Stream Index Value

6. After the students have identified their specimens and determines the Stream Index Value, park staff or the school teacher will lead a group discussion summarizing what they've learned, what they've identified from the wetland or creek, and the importance of indicator species and the Stream Index Value.

On-Site Activity #1	*Student Information*	Water Bugs

In the Pre-Visit Activity #1, "Water Wonders" you took a close look at the importance of water and the water cycle. Then in Pre-Visit Activity #2, "Wetland Metaphors" you dissected apart the functions and ingredients in a wetland. For your visit to Sandy Creek Park, you need to know more about the importance of a creek.

A creek is an **ecosystem**. The plants and animals in creek, along with the physical surroundings form an interdependent system. You might compare a creek to a fine stew or soup. The various living or once living parts are the ingredients for the stew or soup. Usually the more ingredients you add, the better the stew. A stew also needs spices to make it taste just right. In our analogy, the spices refer to the nonliving parts of the creek ecosystem- oxygen, minerals, sunlight, etc. If you try to make a stew with just one ingredient, or if you leave out an important spice, your stew is not going to be good.

Here is the recipe for a healthy creek:

<u>Some sunlight</u> – just enough for the algae, moss, diatoms, and aquatic plants to carry on photosynthesis. (Too much sun heats up the water and robs it of dissolved oxygen)

<u>Fallen leaves</u> – they provide the main source of energy for a creek system. In the fall, leaves drift down from the trees into the water where they soon sink in the bottom or get caught in logjams or wedged between rocks. At this point, bacteria and fungi climb aboard the leaves and begin to "munch out", causing the leaves to decompose and break down in to smaller pieces. The half-eaten leaves, bacteria and fungi are eventually swept downstream where they provide food for munchers, grazers and filter feeders – wonderfully adapted macroinvertebrates (macros), such as stonefly **nymphs**, mayfly nymphs, and caddisfly larvae. These organisms further break down the leaves into a very find mulch called detritus. In addition to the munchers, grazers and filter feeders, there are other types of macros that prey on other macros. Lots of different kinds of macros are a sign of a healthy creek.

<u>Dissolved oxygen and carbon dioxide</u> – all the animals in the creek need dissolved oxygen to breathe. These same animals breathe out carbon dioxide, which is essential for algae and other aquatic plants. These plants in turn take in carbon dioxide and give off oxygen.

<u>Aquatic plants and animals</u> – aquatic plants like riverweed and water willow provide cover for macros and small minnows. All the aquatic animals in the river provide food for each other and non-aquatic animals in a complex **food web**. When all these various plants and animals die or excrete waste, they return essential nutrients that were borrowed so that they could live.

Various minerals – the fine spices of a creek include calcium bicarbonate, potassium, nitrates and phosphates. These ingredients help balance a river's pH; provide building material for the shells of snails, mussels, clams, and crayfish; help fish breathe more efficiently; and act as natural fertilizers essential for aquatic plants.

These are just the minimum ingredients needed for a healthy creek. If there are plentiful numbers of many different **species** of plants and animals in a creek, then we have a healthy creek. Taking samples of these aquatic plants and animals is a means to monitor the quality of a river's waters.

Aquatic Sampling Data Sheet

Name: ____________________ Date: ______________________________
Location: ________________________ Temperature: Air: _____ Water _____
Methods of Sampling: ___________________ Stream Index Value: _________

Instruction:
Use the "Key to Common Macroinvertebrates" or "Pollution Tolerance of Macroinvertebrates" chart to identify organisms. Record the species of organisms found in space below, using the chart to classify them by their tolerance levels (See example below.)

Group I	Group II	Group III
1. ____________________	1. ____________________	1. ____________________
2. ____________________	2. ____________________	2. ____________________
3. ____________________	3. ____________________	3. ____________________
4. ____________________	4. ____________________	4. ____________________
5. ____________________	5. ____________________	5. ____________________
6. ____________________	6. ____________________	6. ____________________
7. ____________________	7. ____________________	7. ____________________
Total - ________________	Total - ________________	Total - ________________

Calculate the Stream Index Value by multiplying the number of species of organisms in each group by the index for that group. Then, add the resulting three numbers to obtain the Stream Index Value (see example below.)

(3 x no. of species – Group I)
(2 x no. of species – Group II)
+ (1 x no. of species – Group III)
= Stream Index Value

Cumulative Index Values	Stream Index Rating
23 and above	Excellent
17 to 22	Good
11 to 16	Fair
10 to less	Poor

What is the Stream Index Value for this river? _______________
What is the Stream Index Rating? ______________________

List five factors (or ingredients) needed for a healthy river ecosystem. Make sure that you include at least two nonliving factors. Explain why each factor is important to the health of the river:

1. ____
____
2. ____
____
3. ____
____
4. ____
____
5. ____
____

On the back of this paper, list three macroinvertebrates and, for each one, describe an adaptation that allows it to live in a particular aquatic habitat.

On- Site Activity #2 *Educator Information* <u>Mind your p's and H's</u>

Major Concepts:
- Water Quality
- pH range (acid-neutral-base)
- Acid precipitation

Objectives:
- Demonstrate the use of litmus paper and the LaMotte test kit for determining pH.
- Find the pH of at least three common substances
- List two natural influences that can affect the pH range in the wetland and creek.
- List two human influences that can affect the pH rating of a river.
- State the North Carolina Environmental Management Commission's pH range for Aquatic Macroinvertbrates (6.0 – 9.0)

Learning Skills:
- Observing
- Classifying
- Reading informational material with complex vocabulary
- expanding on information

Location: Sandy Creek Park

Group Size: 8 students

Time Considerations
Activity – 30 minutes

Appropriate Season: Springtime or early fall

Materials provided by the teachers: pencils, student worksheet (one copy per student), test paper, LaMotte Test Kit, sample items (distilled water, vinegar, lemon juice, Rolaids, Coca-Cola, soap, baking soda)

Materials provided by the park educators: "pH Ranges That Support Aquatic Life" Poster, rainwater collected at Sandy Creek park

Educator Information: In this activity, students will test the pH of several household products, as creek and wetland water. Either the school teacher or park educator will lead a discussion focusing on the pH scale, what pH ranges aquatic life will tolerate, and natural and human influences that can change the pH of a creek or wetland. The students will use litmus paper to test the pH of several items and record their results on the "Sample pH Range" worksheet. They will also use a LaMotte test kit to test the pH of distilled water and Sandy

Creek water and wetland water. This will also be recorded on the same worksheet. Either the school teacher or park educator and the students will discuss their results and compare them to the “pH Range that support Aquatic Life” poster. They will note the extreme ranges of the samples and be able to determine which **organisms** might be able to live in water with that pH.

Have the students read the Student’s Information prior to the park visit.

Special Considerations: Chemical reagents are used in water quality testing. Because misuse of these chemicals can be hazardous, standard chemical protection procedures will be required. Goggles and rubber gloves will be provided for all students handling testing kits. These must be worn at all times during test procedures. The educator will assist in seeing that all safety precautions are followed.

Credit: Eno River State Park Environmental Education Learning Opportunity

On-Site Activity #2 *Doing the Activity* Mind your p's and H's

1. Review the pH information provided in the Student's Information. Discuss what the term pH means and how it is measured. Be sure to use an example – if the creek's pH changes from 6 to 5, this means the creek is now 10 times more acidic; from 6 to 4 would mean it is 100 times more acidic.

2. Have two students test the pH of Sandy Creek water using the LaMotte Test Kit. Have one student read how it is done from the instructions with the test kit while the other student does the test. Have the students then test the pH of the Sandy Creek Park Wetland, the pH of distilled water and the pH of rainwater using the LaMotte Test Kit.

3. Discuss the results, reinforcing the Student's Information. If the creek water falls in 6.0-9.0, then it met the standard for fresh water set by the N.C Environmental Management Commission. Generally, if the pH falls in 6.5-7.5, it is the best range for macroinvertebrates."

4. Review how aquatic life is affected by pH. Be sure to cover the concept of tolerance ranges for different organisms. Use an example such as the one on mayfly nymphs. Also, discuss the range of pH tolerance found on the "pH ranges that Support Aquatic Life" poster.

5. Discuss with the students that the rainwater, collected in the park rain gauge will have a varying pH. Review the **acid precipitation** section of the Student's Information. Emphasize that rain is naturally acidic, with a pH around 5.5. Rain is buffered by the soil, resulting in creek water with a pH between 6 and 8. Note that there are naturally acidic bodies of water, particularly in the eastern part of the state. Finally discuss what acid precipitation is, where it comes from, and how it changes the pH of the creek water and wetland water.

6. Discuss other ways the pH of streams is changed, reinforcing the Student' Information, particularly:

a. pH increases with increases in **effluent** from **sewage** treatment plants (effluent is high in ammonia which neutralizes acids)
b. pH increases with photosynthesis in plants (photosynthesis removes carbon dioxide, CO_2)
c. pH increase with **aeration** by **riffles** and rapids (aeration adds oxygen, O_2)
d. pH decreases with an increase in rainfall (rainwater is typically more acidic)
e. pH decreases with decomposition of plants (**decomposition** removes O_2)
f. pH decreases with **respiration** (animal breathing releases CO_2

7. Discuss the pH of household products (the pH of many products used for cleaning is basic, while the pH of items that taste sour is acidic). Explain the test procedure using litmus paper can test a broad range of pH and that each litmus paper type covers a specific range within the pH scale.

8. Have one student come forward and pick a product to test. Prior to testing, have the student decide if the product will be basic, acidic or neutral. Have the student select a strip of litmus paper from within the range they think appropriate and place it in the product. Match the color on the litmus paper chart. Discuss the results and have the students mark their own worksheet.

9. Continue the process until all the products are tested.

10. To test Rolaids, soap and baking soda, dissolve the product with an equal amount of distilled water. Remind the students that pure, deionized water contains equal numbers of H+ and OH- ions and is considered neutral, pH of 7. Note that this will slightly buffer the true pH of these products, but the products will still provide examples of basic pH's. Points out that Rolaids and baking soda are both basic (pH of 9) and that baking soda could be used for acidic indigestion just as well as Rolaids. Discuss some of the foods that give us acid indigestion. [Pizza (tomatoes), chili (tomatoes), orange juice (citric acid), etc.] We, too, are living organisms and cannot tolerate drastic changes in pH! To test "you", have a student place the tip of a strip of litmus paper on his or her tongue. Have the class decide if the student is acidic, basic, or neutral prior to the test.

11. Sum up the activity by emphasizing that aquatic life is affected when the pH varies a great deal from neutral. A change in the pH of a creek or wetland can be one of the first indicators of water quality problems and can quickly affect the aquatic life in the water.

On-Site Activity #2 *Student Information* <u>Mind your p's and H's</u>

The term pH means (p)ower of (H)ydrogen ion activity. Scientists use the **pH scale** to define the degrees of acidity/basicity in soil and water. On one end of the scale, a pH of 0 is extremely acidic (many hydrogen ions, H+), whereas at the other end of the scale, a pH of 14 is extremely basic (many hydroxide ions, OH-). A pH of 7 is neutral (equal numbers of H+ and OH- ions), being neither acidic nor basic. pH is measured on a logarithmic scale with each number representing a factor of 10. Thus, a change in a creeks pH from 6 to 5 means that the creek is now 10 times more acidic; from 6 to 4 means it is 100 times more acidic.

North Carolina has established water quality standards. For all fresh waters, except swamps, the acceptable pH range is 6.0 – 9.0 (swamps can have a pH as low as 4.3).

Aquatic life is affected when the pH varies a great deal from neutral. Different **organisms** tolerate varying ranges of pH, and the population of aquatic organisms will change if the pH changes favor certain **species.** For example, mayfly nymphs do best when the pH is around 6.5, but they usually cannot survive if the pH drops below 5.0. Most macroinvertebrates do best if the pH is between 6.5 and 7.5.

The pH is rainfall is naturally acidic, usually registering from 5 to 5.5. However, many soils are somewhat basic and "buffer" the rainwater by raising its pH, making it less acidic. As a result, despite the pH of non-polluted rain being around 5.5, the pH of most stream water is between 6 and 8. However, you can find naturally acidic water in swamps, bogs, Carolina bays, and blackwater rivers in the eastern part of the state. There, the soils contain large amounts of peat (partially decayed plant material) which is acidic.

Some acidic waters are not natural, but the result of acidic precipitation. Acid precipitation falls in the form of rain, snow, flog, sleet, and hail. The acidity results primarily from the mixing of water vapor with sulfur dioxide (from coal burning power plants) and nitrous oxides (from cars and trucks) in the atmosphere. Acid precipitation can cause changes in the pH of our waterways.

The pH of water increases (becomes more **alkaline** or basic) with increases in the following: **effluents** from **sewage** treatment plants (effluent is high in ammonia), photosynthesis in plants (photosynthesis removes carbon dioxide, CO2), and **aeration** by riffles and rapids (aeration adds oxygen, O2).

The pH of water decreases (becomes more acidic) with each of the following; increases in rainfall (allowing little or no buffering from the soil), **decomposition** of plants (decomposition removes O2) and respiration (animal breathing releases CO2).

Changes in pH can give valuable clues to water quality changes. A pH change, either an increase or decrease, may be an indication of biological processes such as decomposition of organic matter, photosynthetic activity or an

increase/decrease in pollutant levels.
Monitoring the pH of our creeks and wetlands is of great importance. It can alert us to changes in our water quality and help to protect our waters by giving us clues to the sources of the changes.

Sample pH Range														
	ACID				**NEUTRAL**						**BASE**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Sandy Creek Water														
Sandy Creek Wetland Water														
Distilled Water														
Rainwater														
Rolaids														
Soap														
Baking Soda														
Coca-Cola														
Lemon Juice														
Vinegar														